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NIF PEPC LRU Test Stand– Safety Note Addendum

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U.S. Department of Energy

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DISCLAIMER

This work was performed under the auspices of the U. S. Department of Energy by the University of California, Lawrence Livermore National Laboratory under Contract No. W-7405-Eng-48.

MECHANICAL ENGINEERING SAFETY NOTE ADDENDUM

to MESN01-028-OA

NIF PEPC LRU Test Stand

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5 September 2001

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Revision Justification

It is necessary that the NIF PEPC LRU Test Stand be modified to accommodate a new experiment. This modification will involve boring two 1/2" holes in the Center Loaded Upper Beam of the stand. These holes will allow a small wire to pass through half of the length of one of the long sections of 80/20 part 3030. The holes could adversely effect the load-bearing capabilities of an important structural member of the stand so calculations must be done to assure a minimal risk of part failure.

Design Modifications

A single, 1/2" diameter hole will be drilled in two places along one of the Center Loaded Upper Beams. These holes will only penetrate halfway through the structural member. One hole will be located near the center of the beam (actually about 4" off-center) and the other will be located 6" from the end. In order to estimate their effect on the beam conservatively, the calculation will assume a hole in the middle of the beam's span (point of max. bending moment).

Assumptions

The load of the cell will be modeled as though it is distributed evenly between the two long upper beams. The center loaded upper beam that is to be modified will be modeled as a simply supported beam with a point load in the center of the span (worst case). Because the beam is actually closer to a fixed-support beam, the calculations are conservative by at least a factor of two. This is due to the fact that the bending moment at the center of a simply supported beam ($M = F \bullet l / 4$) is twice that in a beam with fixed supports ($M = F \bullet l / 8$). In addition, the calculations completely ignore the 45° supports on the beam, which also add to its stability.

Testing Requirements

Because the modifications to the Upper Beam could change the load bearing capabilities of the structure, the stand should be load tested to 150% of the 1.8 kip live load, which is 2.70 kips.

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Calculations

$M := 23.4\ kip \bullet in$ Bending moment in the beam. See the original safety note for this calculation.

$C := 1.5\ in$

$I := 3.3625\ in^4$

Find new I value (I'):

$I_0 := b \bullet h^3/12$

$b := 0.5\ in$ This is an extremely conservative estimate of width of the removed section based on the attached drawing (Figure 1).

$h := 0.5\ in$ The diameter of the hole.

$I_0 := 0.005208\ in^4$

$I' := I - I_0 = 3.35729\ in^4$ The new MOI of the beam.

New Bending Moment:

$\sigma' := M \bullet c/I'$

$\sigma' = 10.455\ ksi$

$F := 900\ lbf$ Half of LRU weight

$A := 3.371\ in^2$ Area of original cross-section

$A_0 := h \bullet b = 0.25\ in^2$ Area removed from cross-section

$A' := A - A_0 = 3.121\ in^2$

New Shear:

$\tau := F/(2 \bullet A')$

$\tau = 144.2\ psi$

Von Mises Calculation:

$\sigma_{vm} := (\sigma^2 + 3 \bullet \tau^2)^{1/2}$

σ_{vm} = **10.458 ksi**

Factor of Safety:

$\sigma_y := 35$ ksi

$FS := \sigma_y / \sigma_{vm}$

FS = 3.347 The hole changed the factor of safety by only 1.57%.

Figure 1: Cross-section of 3030 Beam